

Automatic Platform Bridge Connector in Railways Using Embedded System

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Abstract

Railway accidents and passenger inconvenience often occur due to unsafe gaps between trains and station platforms during boarding and alighting. To overcome this issue, the proposed project titled “Automatic Platform Bridge Connector in Railways Using Embedded System” aims to design a smart and automated bridge mechanism that enhances passenger safety and operational efficiency. This system focuses on concept design, sensing, and control system development using an embedded platform. Ultrasonic or infrared (IR) sensors are used to detect the arrival, departure, and proper alignment of the train with the platform. Once the train is correctly positioned, a microcontroller-based system such as Arduino or STM32 processes the sensor signals and activates a DC motor to extend a mechanical bridge that fills the gap between the train and the platform, ensuring safe passenger movement. When the train is ready to depart, the sensors signal the controller to retract the bridge safely and automatically. The system also includes LED indicators to alert passengers about approaching trains, a relay module for accurate motor control, and a 16×2 LCD display to provide real-time information on train detection and bridge status. By eliminating manual operation, this automated solution significantly reduces the risk of accidents, improves passenger convenience, and ensures safe, reliable, and intelligent platform connectivity in railway environments.

Keywords: Embedded Systems, Automatic Platform Bridge, Railway Safety Automation, Sensor-Based Detection, Microcontroller Control System

1. Introduction

Railway transportation plays a crucial role in connecting cities and facilitating passenger movement. However, one of the common safety concerns at railway stations is the gap between platforms and train doors, which can cause serious accidents, especially for elderly or disabled passengers. Traditional methods rely on manual bridge placement or warning announcements, which are often unreliable and prone to human error. To overcome these challenges, the project “Automatic Platform Bridge Connector in Railways Using Embedded System” introduces an automated mechanism that connects the gap between two platforms using a movable bridge controlled by an Arduino microcontroller. The system employs Infrared (IR) sensors to detect the arrival and departure of trains. When a train approaches, the IR sensor detects its presence, and the Arduino deactivates the bridge movement to ensure safety.

Once the train departs, the system automatically activates the DC motor to move the bridge back into position, reconnecting the platforms. A relay module is used to control the direction of the motor, while an LED indicator alerts passengers about an incoming train. A 16x2 LCD display provides real-time information such as “Train Detected,” “Bridge Retracted,” or “Bridge Connected.” This intelligent system minimizes manual intervention, ensures passenger safety, and enhances the efficiency of railway operations. The proposed embedded system can be easily integrated into existing railway infrastructure, making it a cost-effective and scalable solution for modern railway automation. Its combination of sensor-based detection, automatic control, and user alerts helps create a safer and smarter transportation environment.

2. Literature Review

Ramesh, K., et al. (2021) – “Automation of Railway

Platform Gate System Using IR Sensors and Microcontroller” This paper presents an automated gate system that uses IR sensors to detect trains and a microcontroller to control motorized barriers. Automated systems significantly reduce human error and improve railway safety. Supports the use of IR sensors and Arduino for reliable train detection and automatic bridge control [1]. Priya, S., & Anitha, M. (2022) – “Smart Railway Crossing Control Using Embedded Systems” A PIC-based embedded system was designed to control crossing gates using sensors and relays. Automation ensures precise timing for gate operations and minimizes accidents. Demonstrates how relays and sensors can be integrated with Arduino for bridge automation [2]. Ranjith, P., et al. (2020) – “IoT-Based Train Detection and Passenger Safety System” IoT integration with sensors enables real-time train position updates and safety alerts. IoT systems can enhance monitoring and remote control in railway infrastructure. Suggests the possibility of future IoT integration in bridge control systems [3]. Divya, K., & Suresh, R. (2023) – “Automatic Railway Platform Safety System Using Embedded Technology” Uses microcontroller-based automation to prevent accidents caused by gaps between trains and platforms. Embedded control provides cost-effective safety improvements. Supports using Arduino-controlled DC motors for automatic bridge mechanisms [4]. John, A., et al. (2019) – “Microcontroller-Based Railway Automation System” Discusses automation of various railway components using microcontrollers and sensors. Real-time detection and automatic actuation increase system efficiency. Reinforces the reliability of microcontroller-based automation for railway applications [5].

3. Existing System

In the existing railway platform systems, the connection between two platforms or the gap between the train and the platform is managed manually [6]. Railway staff are responsible for placing and removing portable bridges when required. This process is time-consuming, prone to human error, and often leads to safety risks, especially during peak hours or emergency situations. Moreover, in many railway stations, there is no

automatic alert mechanism to inform passengers about the arrival of trains [7]. Passengers often rely on manual announcements, which may not always be timely or audible. Manual bridge operation also increases the risk of accidents if the bridge remains extended while a train is approaching. The lack of automation in existing systems results in inefficiency, delays, and potential hazards. Therefore, there is a strong need for a fully automated and sensor-based platform bridge control system to enhance safety and reliability in railway operations [8].

4. Proposed System

The proposed Automatic Platform Bridge Connector introduces an embedded system-based automation to eliminate manual intervention and improve passenger safety. The system uses an Arduino microcontroller as the main controller to manage sensors, motor, and display units. Two IR sensors are installed at specific distances to detect the incoming and outgoing trains. When the IR sensor detects a train, the Arduino processes the signal and triggers the relay module to turn off the DC motor, thereby retracting the bridge to ensure no interference with the train's movement. Once the train has safely departed, the sensors signal the Arduino again, activating the DC motor to reconnect the bridge automatically. An LED indicator provides visual alerts to passengers about the bridge status and train approach. A 16x2 LCD display shows messages like “Train Approaching,” “Bridge Retracted,” and “Bridge Connected.” The system ensures timely and accurate bridge operation, thereby enhancing the efficiency, safety, and automation of railway platforms. This approach not only prevents accidents but also demonstrates how embedded systems can be used to modernize traditional railway infrastructure with cost-effective and intelligent automation.

5. Result

The implemented Automatic Platform Bridge Connector successfully demonstrates the concept of railway safety automation using embedded systems. The project effectively utilizes IR sensors to detect train movement and triggers automatic bridge control through the Arduino microcontroller. During testing, when a train (simulated object) passed the entry IR sensor, the system instantly detected its presence. The relay turned off the DC motor, retracting the bridge

to prevent accidents. The LED indicator glowed to warn passengers, and the LCD display showed the real-time message “Train Detected – Bridge Retracting ” Once the train cleared the platform, the exit IR sensor detected the departure, and the Arduino activated the motor again to reconnect the bridge automatically. The LCD displayed “Train Left – Bridge Connecting.” The bridge returned to its original position, ensuring safe crossing for passengers The system was tested under different lighting and environmental conditions, and the IR

sensors responded reliably. The bridge’s response time was minimal, ensuring safety without delay. Compared to manual bridge operation, this automated solution eliminated human errors, improved accuracy, and increased passenger safety and convenience. This design can be expanded by adding IoT connectivity for remote monitoring or voice announcements for visually impaired passengers. The system proves that embedded automation can be an effective, cost-efficient, and scalable solution for modern railway stations.

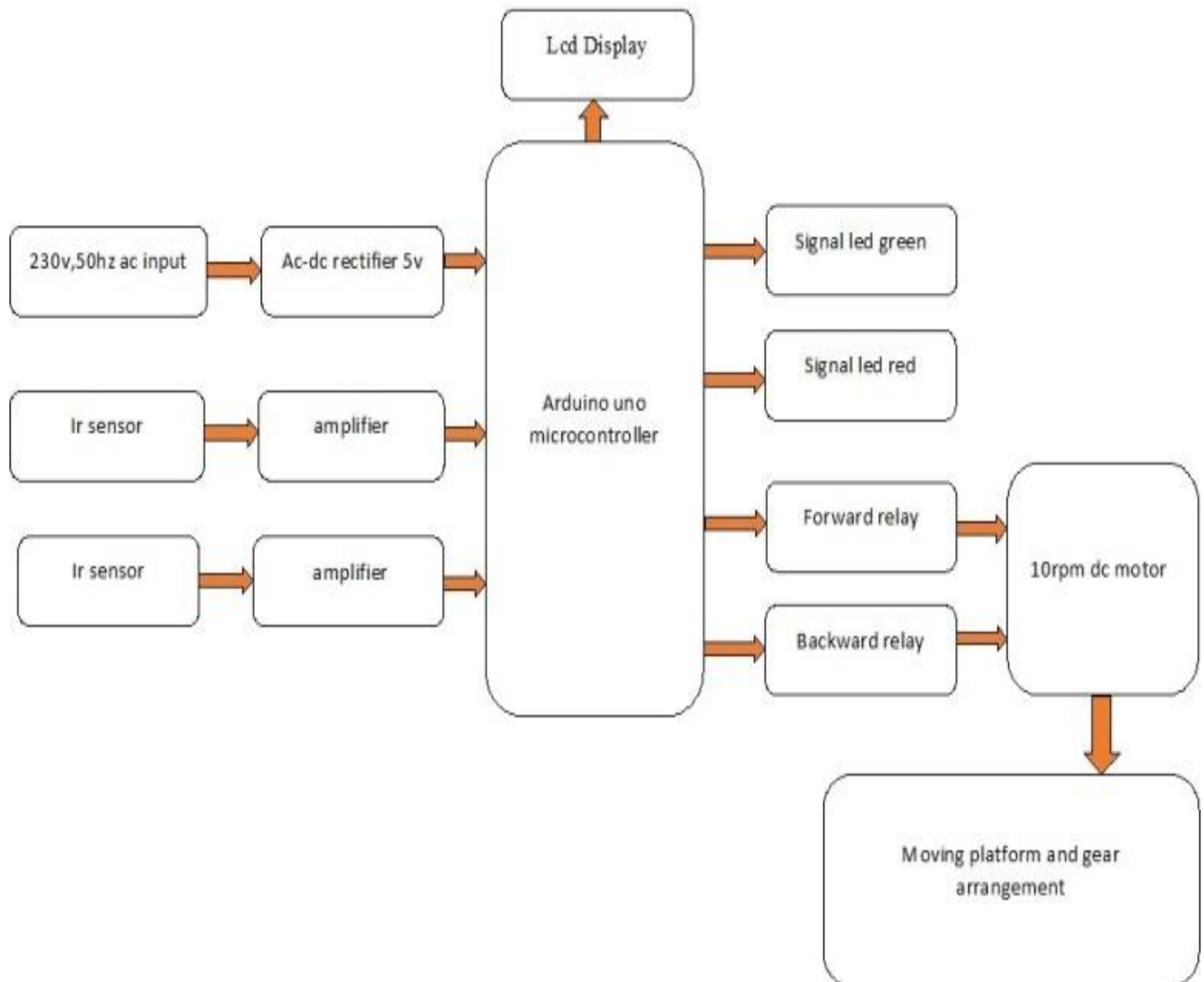


Figure 1 Proposed Diagram

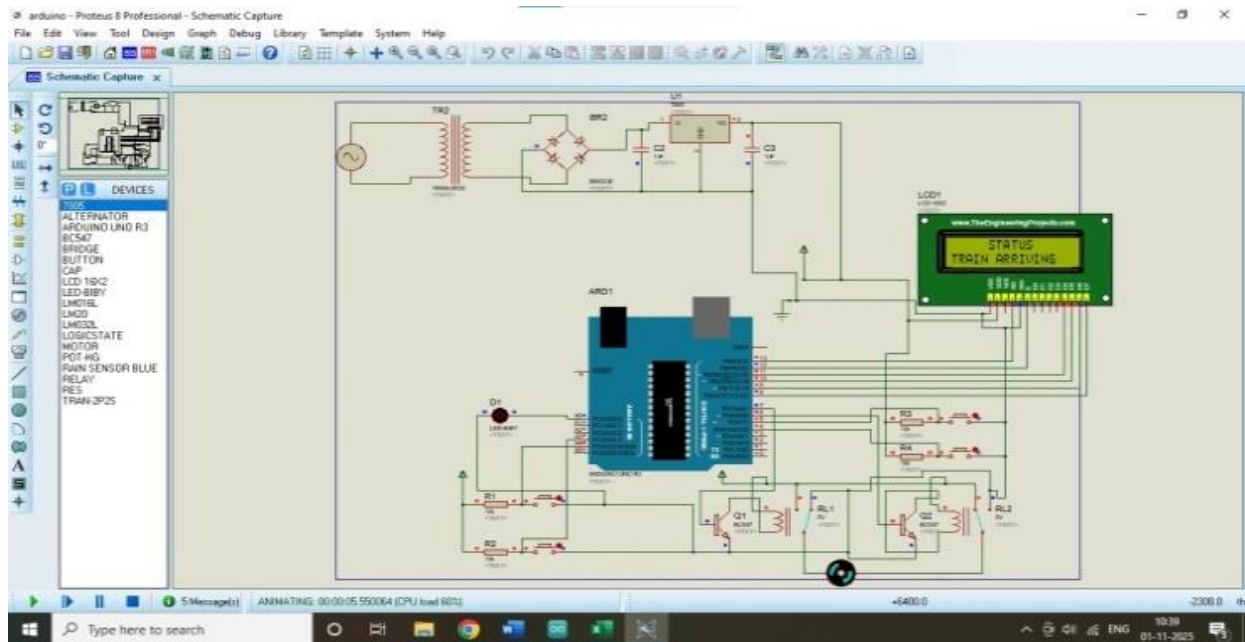


Figure 2 Train Arrival

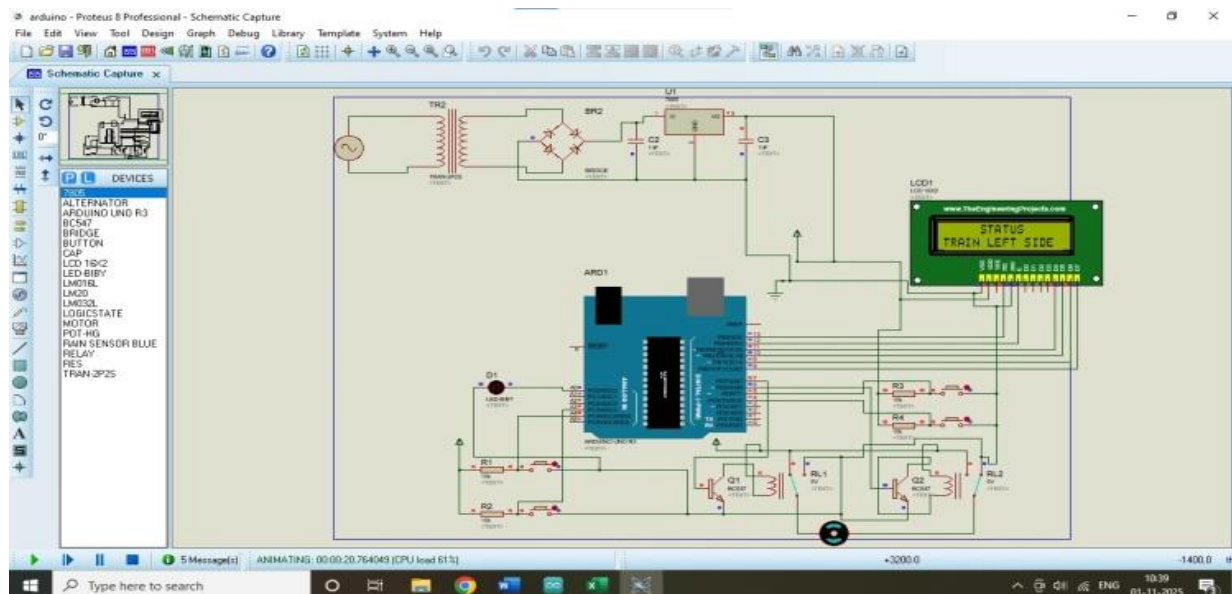


Figure 3 Train Left

Conclusion

The project “Automatic Platform Bridge Connector in Railways Using Embedded System” provides an innovative and practical solution to enhance passenger safety and operational efficiency in railway platforms. By using Arduino, IR sensors, DC motor, and relay modules, the system achieves

automatic detection of trains and real-time control of the platform bridge without manual intervention. The results show that the system operates accurately in detecting train movements, retracting the bridge during train arrival, and reconnecting it after the train departs. This automation minimizes accidents, saves

manpower, and improves passenger convenience. In conclusion, the proposed system demonstrates the potential of embedded technology to create a safer and smarter railway infrastructure. It can be further developed by integrating IoT for remote supervision, solar power for energy efficiency, and wireless alerts for enhanced functionality in future implementations.

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